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What makes socio-ecological systems robust? An institutional analysis of the 2000 year-old Ifugao society

Eduardo Araral
Lee Kuan Yew School of Public Policy
National University of Singapore

What makes socio-ecological systems robust?
An institutional analysis of the 2000 year-old Ifugao society [1]

ABSTRACT

Scholars have often puzzled over why ancient socio-ecological systems (SES) have collapsed or survived overtime. This paper attempts to explain the case of the 2,000-year old Ifugao SES and the contemporary challenges they now face. Five observations can be drawn. First, the Ifugao case does not fit some of the conventional theoretical explanations for the collapse or survival of SES. Second, the Ifugao's primogeniture system of property rights along with the their customary laws and practices have played important roles in maintaining the robustness of their SES in the past 2,000 years through their effects on ecological integrity. Third, the Ifugao SES today is faced with contemporary challenges with varying effects on its robustness: integration into a post-colonial social order, the effects of tourism and agricultural development, migration, urbanization and the introduction of Christianity and mass education. Fourth, despite these changes, the collapse of the Ifugao SES is not a certainty (i.e. shift to a new domain of attraction that cannot support a human population, or that will induce a transition that causes long-term human suffering).

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INTRODUCTION

Scholars have puzzled over why ancient socio-ecological systems (SES) have collapsed or survived overtime. Classic examples of collapsed SES include the Eastern Island, Pitcairn Island, Henderson Island, the Anasazi, the Classic Lowland Maya, the Hohokam of Arizona and the Greenland Norse collapsed. In contrast, robust SES include the Icelanders (1,100 years), the Tonga for 3,200 years, New Guinea Highlands for 7,000 years as well as the Dutch water boards (Kaijser 2002), the lobster fisheries in Maine (Acheson 2003), the Hatfield Forest (Rackham, 1988) as well as farmer organized irrigation systems in Bali (Lansing, 1991), Philippines (Siy, 1982) and Spain (Maass and Anderson 1986).

Five competing explanations have been put forward by scholars such as Tainter (1988) and Diamond (2005): Malthusian theory on population growth and resource depletion; political theories postulating violent power struggles; sociological theories postulating class conflict, social dysfunction and mismanagement; chance events or insurmountable natural catastrophes; and finally, complexity theory.

Malthusian and complexity theories come closest to specifying a causal model between explanatory and outcome variables. For instance, the Malthusian model suggests that collapse of ancient societies tended to follow a similar course: population growth forces people to adopt intensified agricultural production and to expand farming from the prime lands onto marginal land. Unsustainable practices led to environmental damage (deforestation and habitat destruction, soil problems, water management problems, etc) and the consequent food shortages, starvation, wars, disease and consequently the loss of some of the economic, social, political and cultural complexity that they developed at their peak.

Complexity theory, on the other hand, suggests that 1) human societies are problem solving organizations; 2) socio-political systems require energy for their maintenance; 3) increased complexity carries with it increased costs per capita; and 4) investment in socio-political complexity as a problem solving response often reaches a point of declining marginal returns, which limited the abilities of ancient societies to respond sustainably to changes (Tainter, 1988).

This paper attempts to explain the longevity and robustness of the 2,000 year-old Ifugao SES, a UNESCO World Heritage Site. Its focus is on the logic of their institutions, specifically their property and customary laws, and enforcement mechanisms and the contemporary challenges they face. I use the term institutions in the conventional sense referring to the formal and informal rules of the game and their enforcement mechanisms (North, 1990). I use the term robustness in the same sense used by Carlson and Doyle (2002) as "the maintenance of some desired system characteristics despite fluctuations in the behavior of its component parts or its environment." Anderies et al (2004) provides a slightly nuanced and anthropocentric definition, i.e. an SES is robust if it prevents the ecological systems upon which it relies from moving into a new domain of attraction that

cannot support a human population, or that will induce a transition that causes long-term human suffering.

Robustness is a concept closely related to resilience, developed in ecology, which measures the amount of change or disruption that is required to transform the maintenance of a (natural) system from one set of mutually reinforcing processes and structures to a different set of processes and structures (Holling, 1973). More recent developments in resilience theory emphasized the concept of adaptive capacity (Gunderson and Holling, 2002). Anderies et al (2004), however, argue that while these ideas are useful in a descriptive sense, they are less useful for studying designed systems because it is not clear how adaptive capacity can be designed and at what cost given the uncertainties in a linked socio-ecological system.

In contrast, robustness emphasizes the cost-benefit trade-offs associated with systems designed to cope with uncertainty in SES. As such, it is a more appropriate concept when trying to understand how SES can deal with disruptions. Carpenter et al (2001), however, notes that in the SES literature, which kinds of system failure should be measured have not been clearly defined. Anderies et al (2004) suggests that at a minimum, the following questions must be answered in the study of robustness:1)What is the relevant system? 2) What are the desired system characteristics? 3) When does the collapse of one part of a SES imply that the entire system loses its robustness?

The next section explains the data and methodology followed by results and discussion. The conclusion section provides insights and implications.

METHODOLOGY

Data for this study were drawn from multiple sources such as archival and ethnographic research, participant observation, ground truthing, focus group discussion and key informant interviews, census data, secondary sources, aerial and ground photography as well as participation in an international conference on the Ifugaos.

Extensive archival research at the University of the Philippines (Baguio), which has the largest collection of the most authoritative studies on the Ifugaos, uncovered the pioneering works of anthropologists such as Conklin (1967; 1980) who wrote the seminal Ifugao ethnographic atlas; Barton (1919, 1922) who studied Ifugao customary law in depth and whose work greatly informed this paper; Lambrecht (1967; 1951); Hoebel (1949); Scott (1966,1975) on the social history of the Ifugao; Beyer (1912, 1955), among others. Together, these collections represent the most extensive archival record available on the Ifugao rice terraces, its people and their culture.

Archival research was complemented by fieldwork, which was undertaken from May to October 2008. A team of research assistants was fielded in the municipalities and districts of Banaue, Batad, Asipulo, Hengyon and Mayaoyao. They conducted surveys and focus group discussion among indigenous knowledge experts, *mumbaki* (village priests), members of the Save the Ifugao Terraces Movement (NGO) and officials of the Department of Agriculture and Provincial Planning and Development Office, which

keeps statistical records on the rice terraces. The aerial photography by Conklin and Javellana (2008) was invaluable in providing a visualization of the conditions of the rice terraces.

FINDINGS AND DISCUSSION

The Ifugao SES is found in the Ifugao Province of Cordillera mountainous region of northern Philippines. There are 14 mountain ranges in the province with an average elevation of 1,600 meters above sea level. The Ifugao ethnic group is actually a collection of the several indigenous sub-groups, namely, the Banaue, Bunhran, Mayayao, Halipan, Hapao, and Kiangang. In the dialect, the word *Ipu-gaw* means "inhabitants of the earth."

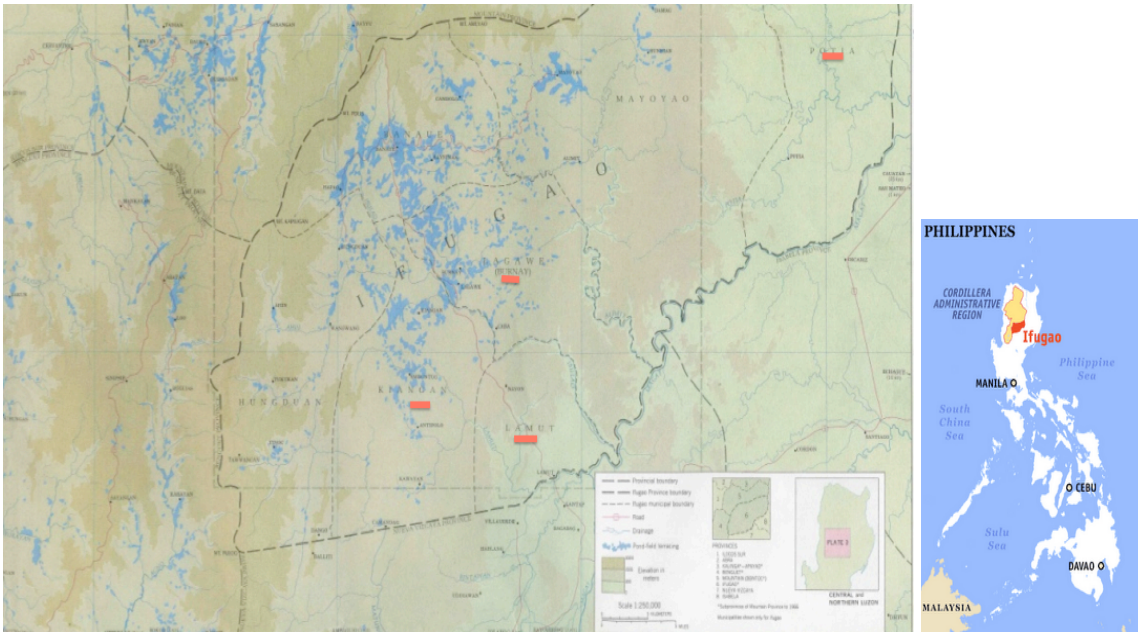
Their ancient society, which has been around for about 2,000 years, essentially revolves around their main source of livelihood, the rice terraces, which were declared by UNESCO in 1995 as a World Heritage Site. The declaration reads as follows:

> *For over 2000 years, the high rice fields of Ifugao have followed the contours of the mountains. The fruit of knowledge passed on from one generation to the next, of sacred traditions and a delicate social balance, they helped form a delicate landscape of great beauty that expresses conquered and conserved harmony between the humankind and the environment.* - UNESCO, 1995.

The age of the terraces actually would vary from place to place. Anthropologists report that, based on a series of radio carbon dating by the University of Georgia Center for Applied Isotope Studies, some terraces could have been established as early as 1555 AD ± 60 years. In other sites, carbon dating estimates put the dates around 7th to 11th Century while in higher elevation sites at 16th century (Maher 1973, 1977). Ifugao families tended to live in small, dispersed and isolated hamlets of one to several dozen households (165-360 individuals per square kilometer of cultivable area) located in agriculturally developed property.

The terraces occupy an area of 4,000 square kilometers in mountainous slopes as steep as 70 degrees and as high as 5,000 feet. Terrace embankments stretch some 20,000 km, equal to the distance halfway around the world, of which 7,000 km are stonewalled (Conklin, 1980). Appendix 1 provides an aerial and ground photography of the terraces. Figure 1 below shows the geographical distribution of the terraces (marked in blue) and the location of partially urbanized towns (orange) with populations exceeding 15,000 individuals.

Figure 1: Geographical distribution of settlements with rice terraces (blue) and partially urbanized towns (orange). Source: Conklin (1980).



Philippine Map: http://indigenousissuestoday.blogspot.sg/2008/02/ifugao-indigenous-peoples-of.html

Operating and maintaining the terraces is a complex feat of structural and hydraulic engineering that requires constant repair, extension, restructuring and dynamic recycling of resources while trying to surmount a variety of uncertainties and shocks. These shocks and uncertainties include 1) unpredictable earthquakes of varying magnitudes, the Philippines being earthquake prone, which often damage streams that feed the terraces and lead to their collapse; 2) frequent landslides due to monsoons and cloudbursts, as the Philippines averages 26 typhoons a year; 3) numerous pests and diseases associated with farming and 4) inherent conflicts over scarce resources such land, water and forests.

The ability of the Ifugaos to build, operate and maintain this complex socio-ecological system in the face of these persistent shocks and uncertainties for the last two thousand years is what makes the Ifugao society different from other ethnic groups in the Philippines and other groups around the world.

Ifugao Institutions

Having survived for 2,000 years, the Ifugao SES appear to be a good example of a robust SES. I speculate that this robustness is due in large part to the logic of the Ifugao institutional structure particularly their customary laws and a primogeniture system of property rights reinforced by credible and low cost enforcement mechanisms. These customary laws and practices evolved from a polycentric constitutional order, which in turn evolved from and were finely adapted to local ecological conditions. I refer to this as the ecological and institutional grafting hypothesis, a view widely supported by Ifugao anthropologists and ethnographers such as Conklin (1965), Keesing (1962), Scott (1965), Lambrecht (1967) and Barton (1919). I also argue that conventional theories, for example

political conflict, Malthusian theories, social theories and insurmountable catastrophes, cannot adequately explain the Ifugao story.

Principles of customary law

The Ifugaos have established several principles of customary law. The first is collective responsibility. Not only the individual who commits an act but his kin in proportion to the nearness of their kinship, is responsible for the act. This applies not only to crimes but to debts and civil injuries as well. The second principle is collective procedure by and between families. These principles are derived from the Ifugao's bilateral kinship, which is the primary legal and social unit, i.e. an individual's responsibility to his kinship takes precedence over self-interest.

Collectivism and bilateral kinship have their economic basis on the need to mobilize substantial amounts of labor to construct, operate and maintain the Ifugao terraces and their mountain ecology. As Bayer (1964) vividly describes:

> *To terrace one hectare of mountain slope would require 10,000 cubic meters of excavation, filling and masonry. Thus, the Ifugao rice terraces alone, which cover an area of 4000 square miles, would require 103.6 million cubic meters of earthworks using bare hands and crude tools.*

Bayer further described the operation of the terraces as follows: During the long off-season, men channel and impound vast amounts of water and invest much labor to repair and expand their fields. Stream water for irrigation is diverted and conveyed by canals for distances of up to six kilometers with water networks totaling 130 km in just one hamlet. Women provide 63 percent of the labor requirement for the whole rice cycle while men are generally responsible for tasks that require more strength and effort such as land preparation, terrace /stonewall and canal maintenance, as well as guarding against water stealing, among others (Table 1).

Table 1: Division of labor and specialization

Male			**Female**		
Farm sequence	*Farm activities*	*Farm labor (person-days/ha)*	*Farm sequence*	*Farm activities*	*Farm labor (person-days/ha)*
2	Stonewall/terrace maintenance	12.5	1	Seedbed prep/sowing/maintenance	7.7
3	Land preparation	27.3	4	Transplanting/ replanting	42.2
5	Irrigation canal repair and maintenance	11.3	6	Cleaning / weeding	20.3
7	Fertilizer application	1.7	7	Fertilizer application	0.3

8	Pest control (male child)	5.1	8	Pest control	3.1
			9	Harvesting	40
10	Threshing and hauling	8.3	11	Seed selection	0.8
13	Storing	3.1	12	Drying	7
14	Milling/powdering	4.7	14	Milling/powdering	3.9
	Total	74		Total	125.3
	Percent (%)	37		Percent (%)	63

Source: Provincial Agriculture Office (PAO), Ifugao Province (2008)

Altogether, it is estimated that one hectare of highland pond field rice requires a minimum of 630 days of farm labor per year (PAO 2008). When terraces and waterworks are under heavy repair or construction, the annual labor requirement may rise to over 1,000 days of farm labor per year. Farm labor is provided by group effort (*ubbu*) among neighbors, families/clans. Men do the site preparations including irrigation ditch and terrace maintenance while women help in the weeding, pest control and harvesting. Another group called the *baddang* helps in constructing and maintaining the terraced walls and canals. Others act as monitors for the canals checking on a daily basis the clogging of the canals and to guard against diversion of the water to other canals.

Principles of Property law

The Ifugaos have developed overtime an elaborate system of property and personal law, which operates without benefit of government. Ancient Ifugao property law is based on the principle of primogeniture rights i.e. – the first-born acquires the right to inherit the entire or substantial part of property of his parents while younger siblings would have to develop or acquire their own properties. The logic of this works as follows: First, for the rice terraces to function properly and sustainably overtime, they need sufficient year round water supply to prevent the drying and cracking of the soil. Year round water supply in turn depends on the functioning of the life support system for the rice terraces - the *muyongs* or family forests and woodlots - which are located above the upper most part of the rice terraces. The *muyongs* are maintained as forest cover for the watersheds that supply the irrigation water of the terraces as well as sources of fuel-wood, timber and food.

Second, in order to maintain the integrity of *muyongs*, an entire area is to be inherited and cannot be subdivided into a smaller area. If the *muyongs* are fragmented, it could spell problems for the sustainability of the terraces. This is the equivalent of vertical integration in the theory of the firm (Williamson, 1985) and one of the reasons for the need to have the primogeniture system of property rights. This rule is reinforced by rules requiring perpetual tenure over rice and forestland. In case an owner abandons a rice field for any period of time, and another farmer takes up the field without objections from the true owner, and makes the land productive again, the latter has the right to use the field for the same number of years that it was abandoned. Moreover, properties

cannot be pawned to another party for an amount higher than the original pawn price. This rule ensures the prompt return of the field to the original owner as soon as he is able to get the amount to redeem the pawned property, a rule that prevents land speculation and is likewise equitable.

Furthermore, farmer interviews reveal that there is no such thing as absentee landlords and that very little land is controlled by non-Ifugaos. Land tenure and usage in Ifugao have been tightly managed and is integrated culturally. Absentee landlords and non-Ifugao landowners could spell problems for maintaining the watersheds and pond fields for which other farmers down stream the terraces are much dependent upon for the functioning of their fields. If the terraces and watersheds in the upper slopes of the mountain are not well maintained, it would pose problems for water management downstream or could result in soil erosion that would damage pond fields down- stream.

Finally, the primogeniture system of property rights is central to maintaining kinship as the primary basis for social relations among the Ifugaos and a mechanism for balancing power among competing interests in the Ifugao society. As Barton (1919) notes:

> *It is preferable for the Ifugaos that a family has at least a powerful member around whom the kin may rally and to whom they may look for aid than to have the family property split into insignificant parcels that would affect little the property of all. The unity of the family is primodial and must be preserved at all times and at all cost.*

Customary law enforcement and rituals

Customary law enforcement among the Ifugaos relies mainly on religious norms and taboos rather that courts or judicial decisions. Religion and law appear conjointly in matters of importance such as transfer of property, ordeals, payment of large fines and peace making.

Field interviews reveal the importance of norms or taboos in mitigating conflicts in the allocation of scarce resources such as water. These norms follow the established principle “first in time, first in line.” For example, in opening of new rice fields, Ifugao law provides that if all the land below a spring is a common land – i.e. without a landowner – he who makes the first rice field below the water source is entitled to all the water needed for his rice field. The owner may sell the surplus water to whom he pleases and the water rights sold are perpetual. Thus: farmer A has a rice field in which there is a spring sells water to another farmer B whose field is at a considerable distance from A. Farmer C has a field immediately below A’s and purchases A’s field and unites it with his own. Land ownership in this case does not involve automatic water rights. Farmer C would have to buy the water rights from farmer B.

Elaborate rules on water allocation can also be found on rules governing irrigation canals. As the field interviews reveal, constructors of irrigation canals may sell their

interest in the ditch and the ditch shared with others becomes an equal burden as to upkeep on all the owners. The constructors of the irrigation ditch who have sold part of the water from their ditch must share the water in time of water scarcity in proportion to the respective areas of the rice fields.

The complex operation and maintenance of the rice terraces overtime requires, among others, a well functioning social order that can easily adapt to the various risks and uncertainties associated with farming in particular and the challenge of survival in the mountain ecosystem of Ifugao. Ifugaos frequently employ rituals and worship of deities. As Barton notes, a horde of major and minor deities are invoked by the Ifugaos at every ritual. The pantheon of deities among the Ifugaos rival that of India with as many as 1,500 deities in various ranks from gods, to demons, monsters, imps and spirits dwelling in trees, stones, mountains, and rivers aside from the omnipresent ancestor spirits (Barton, 1919). Deities are representations of the Ifugao's belief systems to enable them to understand and adapt to the workings of nature and their effects of Ifugao life - from understanding typhoons, earthquakes, pests and diseases of crops, life cycle, etc. In a sense, these deities provide the Ifugaos some form of reassurance to the uncertainties of life in general and of rice farming in particular.

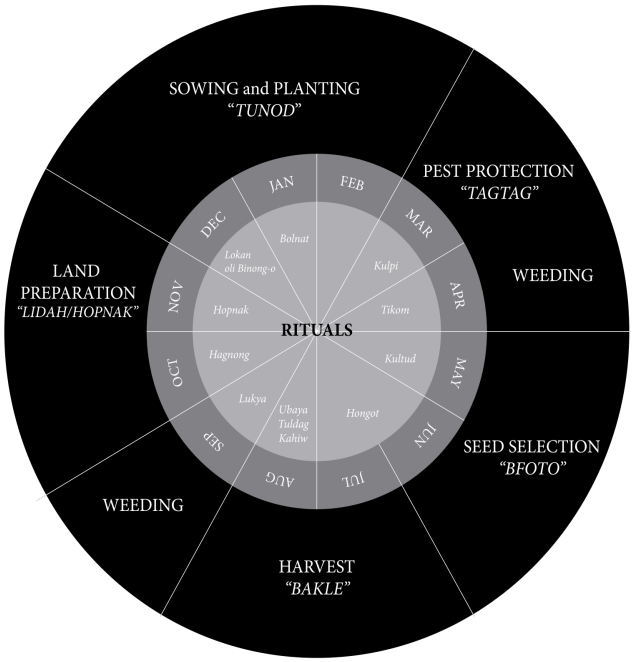
Reverence and worship for deities therefore instills a deep sense of respect among the ancient Ifugaos for the environment, which in turn guides their behavior in relation to nature. In social relations, reverence for deities serves to strengthen taboos and rules of propriety, sense of collective responsibility and reinforces the effects of conjoined law and religion. It must be noted though that the essence of deities among the Ifugaos are no different from other ethnic groups in the Philippines, which is to provide some form of reassurance to the vagaries of nature and as a guide to social relations. Today, among the younger generation of Ifugaos, the essence of these rituals is gradually being eroded as a result of their formal education, exit options and introduction of Christianity. The diminishing value of these rituals is further discussed in the following section on contemporary challenges to the Ifugao SES.

In addition to worship of deities, socialization among the ancient Ifugaos takes the form of rituals, festivals, collective work and a dense kinship networks. All of these serve as mechanisms to ensure the transmission of indigenous knowledge and values and hence help ensure the robustness of the SES. Furthermore, rituals play a central role in the transmission and reinforcement of indigenous knowledge, social capital and values among the ancient Ifugaos from one generation to the next. Conklin (1980) recorded the occurrence of rituals in a small hamlet of Bayninan with 50 inhabitants from 11 households. They held rituals every month for an average of 16 days a month. In all, there were 37 types of rituals held every month for an average of 16 days a month, with some rituals lasting 26 days. Altogether, at least 191 days were spent for rituals in this hamlet during the year 1962-1963.

Rituals and invocation of deities are accompanied by oral chants - the *hud hud* - which can last for three to four days. The UNESCO recognized in 2000 the Ifugao *hud*

hud as one the 19 oral traditions in the world with intangible value. Figure 2 illustrates a typical calendar for cropping and collective works along with associated rituals.

Figure 2: Cropping calendar and associated rituals (Source: Guimbatan, 2008).



During the sowing and planting period (December to February), the Ifugaos practice *loh-wang ritual,* which is done when the seedlings are ready for transplanting. Rice wine and the two chickens are offered giving workers opportunity to drink and socialize. After transplanting, the *asi apoy ritual* is observed. Workers are given at least three days to rest, drink and socialize. After the rice fields have been planted, farmers celebrate in their own homes *(olpi ritual)*, which serves as a thanksgiving for the work done in the rice fields. This is also the time when they ask *Kabuniyan* (god) to spiritually protect their rice plants for a successful harvest. A month after the *olpi ritual*, the ceremony is repeated (hagophop ritual), specifically by those who can afford a second celebration. As soon as the rice plants in the field change color, from evergreen to purple yellow, the *Hanglag or Mamague ritual* is observed. The farmer announces to all the rice goddesses that the harvest season is fast approaching.

During harvesting (July - August), Ifugaos practice the *tungo ritual.* This ritual is done in their respective houses or granaries. The people call the goddesses of rice to come down and ask their favors to make the harvest fruitful and abundant and to guard the fields from evil spirits. Two days before this ritual, the leader of the community will announce the day of the holiday after harvest. This is a thanksgiving ritual to *Kabuniyan* for the successful harvest.

The constant practice of rituals, a communal activity serve to strengthen, among others, social capital amongst the Ifugaos to ensure the mechanism of labor exchange and

keep the bonds of kinship strong. Kinship among the Ifugao is derived from bilateral consanguineal kinship resulting from from marriage, economic circumstances, neighborhood and propinquity (Conklin, 1980).

Contemporary challenges

The contemporary Ifugao SES today is faced with varying degrees of challenges as a result of its integration with the local economy and the national political and legal system. This section briefly traces this process of integration - from the colonial era to the post-colonial period and to the contemporary challenges and their implications for the Ifugao SES.

During the Spanish era (1500s to 1896), historical records show that the Ifugaos were never effectively colonized owing to the remoteness of their mountain ranges. During the American colonial era (1897-1946), Protestant missionaries brought Christianity and an English language education to the Ifugao settlements. This had little immediate impact on the Ifugao SES but would subsequently lay the foundations for the gradual erosion of the use of rituals by younger generations of Ifugaos, at least in settlements where Christianity has taken root. During the Japanese occupation (1941-1945), the population of the province significantly dwindled as a result of casualties and emigration due to disruption in farming livelihoods.

During the post-colonial era, there were several developments, which has important implications to the Ifugao SES. The first, in 1973, was the declaration of the Ifugao rice terraces as a national landmark. The declaration sought to develop the province as a tourism destination as well as to conserve the terraces. This declaration opened the doors for tourism development including roads linking various municipalities and provinces in the region, transport such as an airport in the adjoining province of Nueva Vizcaya, communication facilities, hotels, banks, education, and agriculture development, among others. Today, the Banaue rice terraces - one of the five clusters of the Ifugao terraces - Kiangan, Central Mayaoyao, Hungduan, Batad and Banaue clusters - has become a major tourist destination attracting some 60,000 visitors a year (see Figure 5 in Appendix 1 for an aerial view of physical developments and partial urbanization in the Banaue terraces).

The second major development, the1987 Philippine Constitution provided for significant political autonomy to the Cordillera Region - including the Ifugao province - with the aim of respecting and strengthening indigenous institutions. A more specific law - the Indigenous People's Rights Act - was passed in 1997, which strengthened the claims of indigenous peoples to their ancestral domains. This law stipulates, among others, that indigenous property laws will have precedence over national land laws. This in effect, helped to strengthen the Ifugao's native land laws and their customary enforcement mechanisms. The third major development was the UNESCO recognition of the Ifugao rice terraces in 1995 as a World Heritage Site, which saw a significant increase in tourism arrivals and the pressure it brought to some of the terrace clusters particularly in Banaue.

Urbanization, education, tourism and exit options

Four out of the 11 municipalities in Ifugao province are now partially urbanized (with a population of at least 10,000 individuals). However, of these four, only two (Kiangan and Banaue) have significant terrace clusters. Majority of the settlements with rice terraces are still located in relatively remote rural villages (see Figure 1) while only 10 percent of the Ifugao population live in partially urban areas. Population density is generally low at 69 individuals per square kilometer as of 2007 compared to 60 in 1995.

One example of a partially urbanized municipality is that of Banaue which population increased by 37% to 23,800 since 1990 due to migration from nearby towns and provinces. Tourism based livelihood is a strong pull factor, with the town drawing some 85% of tourist arrivals in the province. Since the 1990s, some 60,000 tourists visit Banaue annually and its surrounding attractions.

Tourism has both positive and negative impacts on the rice terraces. On the positive side, tourism related livelihoods and revenues keep the local economy going and provide strong incentives for locals to sustain the rice terraces. This is particularly the case for the Banaue-Batad terrace cluster, which is a favorite tourist destination. Some of these terraces, especially in Banaue, have been converted for a different land use - residential and commercial (see Appendix 1 Figure 5) - but it cannot also be said that it is not robust in a sense defined by Anderies (i.e. an SES is robust if it prevents the ecological systems upon which it relies from moving into a new domain of attraction that cannot support a human population, or that will induce a transition that causes long-term human suffering).

On the other hand, a new kind of dynamics is emerging in some of the Ifugao settlements as a result of integration with the market economy. These include exit options, migration pressures, labor shortages and rising costs, urbanization and the consequent erosion of customary law and practice of rituals due to the introduction of Christianity and their integration into the market economy. The customary property laws that have kept the integrity of the terraces (i.e. the primogeniture system of property rights) are also under stress due to labor shortages. Mechanisms to transmit indigenous knowledge such as rituals are also slowly disappearing due to high costs, loss of interest by the younger generation and because rituals are considered taboo by the Christianized Ifugaos. The net effect of these is a steady loss of indigenous knowledge, which is crucial for the robustness of the Ifugao SES.

Migration and exit options

The introduction of roads, mass education, media and tourism has created exit options for the Ifugaos. In the last decade, out migration to adjacent provinces, cities and foreign lands have increased in large part because of rising levels of education by younger Ifugaos and because rice farming is not as profitable compared to other livelihood options. Census data (2007) showed that about 35% of Ifugaos obtained at

least a high school diploma and another 41% with some primary schooling. Literacy rate is at 78%.

In a survey in one municipality, overseas employment emerged as one of the main sources of livelihoods for the Ifugaos followed by driving motor vehicles for hire, working as hire labor in nearby provinces, wood carving and weaving to supply the tourist industry (Table 2). The trend towards overseas employment is increasing from 570 cases in 1990 to an estimated 4,500 cases in 2010.

Table 2: Sources of livelihood, Nanulditan, Ifugao (1998), N= 90.

Livelihood activity	Frequency	%
Overseas employment	42	23%
Tricycle driving	38	21%
Farming out of the province	30	17%
Wood carving	27	15%
Weaving	21	12%
Cash cropping	15	8%
Hog raising	8	4%
Poultry raising	4	2%

Source: Bulayo (1998)

The overall effect of these exit options has become evident overtime. In 1980, based on census data (NCSO, 2012) only 2.5% of total arable lands in the province were reported idle compared with 11.5% in 2002. No recent estimates are available as the national census is still underway but it is likely that this figure will be in excess of 20% given the high rate of literacy amongst the Ifugao, which gives them exit options for non-farming jobs in urban areas.

Challenges to rice farming

The integration and urbanization of some Ifugao towns such as Banaue has led to particular challenges to rice farming. For instance, an entomological study in 2005 shows that Banaue is plagued with a host of pest and diseases more significantly compared with rural and less accessible rice terraces such as those in the Hungduan District. For example, 90% of farmers in Banaue report that earthworms pose a major problem to their farms compared with only 53% in Hungduan. Farmers in Banaue also report that the use of pesticides to get rid of earthworms has not been effective and the problem has only gotten worse overtime. It appears that the worms have become resistant to pesticides used by farmers. Ground observations reveal that more terraces are crumbling in Banaue compared with Hungduan. The cost of maintaining these crumbling terraces in Banaue has become more and more expensive because of the need for hired labor. Labor cost in terraced farming range from 75-88%.

Three out of four farmers in Banaue also report that golden apple snails have become a major pest in rice farming compared with only 21% in Hungduan. US Peace Corps Volunteers introduced the apple snails with government encouragement, in the

1980s as a source of protein for farmers in mountainous areas. Since then, the snails have become a major rice pest. In addition, 84% of farmers in Banaue report that rats have become a major pest in rice farming compared with only 60% in Hungduan. Urbanization has led to the growth of rat colonies in Banaue.

Furthermore, in a bid to modernize rice farming in Ifugao, the government promoted in the 1980s the use of high yielding rice and vegetable varieties which are heavily dependent on fertilizers and chemicals for pest control and do not require year round inundation. Absence of inundation promoted the growth of large earthworms (*Polypheretima elongata*) that bore into the soil creating tunnels where water passes and thereby weaken the terraces. Changes in cropping have also increased pests incidence especially rats (*Ratus tanezumi*).

Likewise, in the last three decades, chemical farming has intensified in the terraces along with the introduction of modern rice varieties during the green revolution of the 1970s and 80s. This was followed up with two major agricultural development projects in the region in the 1990s - the Cordillera Highland Agriculture and Resource Management Project funded by the European Union and the Highland Agricultural Development Project funded by the Asian Development Bank. Both projects sought to improve the income of Ifugao farmers by introducing "modern" methods of farming as well as providing credit, technical assistance, farm to market roads, post harvest facilities, among others. These projects also introduced Ifugao farmers to more intensive use of fertilizers and chemicals as well as to diversity to high value crops.

Chemical farming has a particularly corrosive effect on the rice terraces. Soil saturated with chemicals tend to loosen and dry up and crack easily and thus are more prone to soil erosion and therefore requires more labor costs for maintenance. Heavy downpour accelerates the collapse of these dried up terraces (also see Figure 4 of Appendix 1 for a photo). This problem particularly affects newly built terraces but not so much for the old terraces built with organic materials as well as those built from stonewalls.

The response of contemporary Ifugao farmers to the difficult challenges of rice farming is becoming evident in the shift in land use patterns as documented by the Bureau of Agricultural Statistics (2012). For instance, in the 1980s, only 4.3% of total arable land was devoted to permanent crops. By 2002, this has grown to 13.2% or three times increase. More tellingly, the proportion of arable land devoted to rice farming has declined from 23,000 in the 1980s to 17,000 in 2007 while that devoted to corn (which requires less labor and water) has increased to 22,900 hectares (2007) from 10,000 in the 1990s. This shift in land use patterns could possibly be explained by labor shortages and preference for higher value crops such as corn and permanent crops such as fruit trees. This shift to higher value crops in turn could have been driven by the need for higher incomes to finance secondary and tertiary education for younger Ifugaos who go to urban areas to study.

Change in primogeniture rights and rituals

Today, in many contemporary Ifugao families, the primogeniture system of land inheritance is also undergoing change. For instance, younger siblings of the first-born child usually inherit some of their parent's property although less than the first-born child. This practice is likely to continue among contemporary families, leading to further fragmentation of field ponds making rice farming less viable and attractive for the younger generations.

Likewise, reliance on rituals to strengthen social capital and facilitate labor exchange is gradually being eroded because of costs, the loss of interest by the younger, formally educated generation of Ifugaos and because of the influence of Christianity. For instance, the *hud hud*, the tradition of oral chant accompanying the harvest season is gradually being eroded as the younger generation lose interest and rely on formal education. The effect overtime has been that indigenous knowledge required to build, operate and maintain the Ifugao SES is slowly being lost from one generation to the next. This could also possibly account for the significant shift in land use patterns i.e. increase in proportion of arable but idle lands and significant shift to corn farming which does not require these ritual inputs unlike rice farming.

CONCLUSION AND SPECULATION

This paper attempted to explain the longevity and robustness of the Ifugao SES by focusing on the logic of their institutions and the contemporary challenges they now face. Three conclusions can be drawn. First, the Ifugao case provides an empirical account to refute some of the conventional theoretical explanations for the collapse of SES. First, the political hypothesis speculates that societies collapse if there is a power vacuum (Tainter, 1988). The Ifugao society did not face this problem because it did not have a central government. Second, Marxists - for instance Gray (2008) and Woods (2009) - speculate that class conflicts led to the demise of ancient societies. This was not the case either since there is no distinct class stratification among Ifugaos although rank and status is regarded as important. Third, the Ifugaos have managed to surmount frequent earthquakes, typhoons, pestilence and conflicts over resource allocation overtime and thus the catastrophic shock hypothesis do not apply. Fourth, the complexity hypothesis does not apply because the Ifugao SES is not as complex as defined by Tainter (1988). Finally, the Malthusian hypothesis likewise does not apply as the Ifugao population density remained relatively small (60 individuals per square kilometer) and is stable overtime, growing at a rate of 1.3 percent in the last 3 decades.

Second, the study finds that the Ifugao's primogeniture system of property rights along with the their customary laws and practices have played important roles in maintaining the robustness of their SES in the past 2,000 years. The primogeniture system helped ensure the integrity of the Ifugao SES by ensuring the vertical integration of the watersheds and the rice fields and avoiding their fragmentation. Their customary laws and practices in turn helped ensure self-regulation (and hence low transaction costs) as evidenced by the absence of a centralized executive, legislative and judicial unit of

government. In this sense, the ancient Ifugao SES meets Carlson and Doyle's (2002) definition of robustness (i.e. the maintenance of some desired system characteristics - in this case ecological integrity - despite fluctuations in the behavior of its component parts or its environment in this case typhoons, earthquakes, pests and social conflicts).

Third, the Ifugao SES today is faced with contemporary challenges with varying effects on its robustness. These include integration into a post-colonial social order, the effects of tourism and agricultural development, migration, urbanization and the introduction of Christianity and mass education. Of these challenges, perhaps the effect of outmigration and gradual loss of indigenous knowledge and interest from the younger generation pose the most serious challenge in the short to medium run. For instance, the effect of outmigration from rural areas can be seen in terms of the proportion of arable lands now lying idle for extended periods of time. In 1980, only 2.5% of total arable lands in the province were reported idle compared to 11.5% in 2002 and at this rate, is currently estimated to be around 20%. Moreover, the effects of the gradual loss of indigenous knowledge as well as the introduction of government programs on agricultural "modernization" can be seen in changes in land use among the Ifugaos overtime. For instance, this is evident in the significant shift to corn farming and permanent crops (fruit trees), which do not require significant inputs (labor, water, rituals etc) compared to traditional rice farming.

Fourth, despite these changes, the collapse of the Ifugao SES is not a certainty (i.e. shift to a new domain of attraction that cannot support a human population, or that will induce a transition that causes long-term human suffering). It is likely possible that some rice pond fields will shift to different crops (such as corn, permanent crops or higher value crops) and that labor would be imported from outside of the settlements and paid in cash rather than in terms of the ancient practice of labor exchange. The shift to towards crops such as corn and permanent crops or cash crops that do not depend heavily on water would affect the logic of the primogeniture system of rights that has ensured the ecological integrity of the Ifugao SES. This could evolve into a various forms of land and water rights - as is already slowly happening (i.e. younger siblings of the first-born child usually inherit some of their parent's property although less than the first-born child.

Finally, the Ifugao case is useful in partly answering Anderies et al (2004) question on the usefulness of the concept of adaptive efficiency, which has become a core concept in the study of resilience theory. They argued that this concept is useful in a descriptive sense but less useful in studying designed systems because it is not clear how it can be designed and at what cost given the uncertainties in a linked socio-ecological system. This case study has shown how the institutions supporting the Ifugao SES have been designed and what their associated costs have been in terms of the construction, operation and maintenance of the rice terraces given the fluctuations and uncertainties in the behavior of its component parts. Future research would have to take a closer look at the emerging patterns of institutions that the Ifugaos employ in response to (or lack thereof) the contemporary challenges they face and whether or not the Ifugao SES would remain robust.

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